EP-0042423

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 3: B32B 3/26, 5/18	A1	(11) International Publication Number: WO 81/01816 (43) International Publication Date: 9 July 1981 (09.07.81)

(21) International Application Number: PCT/US80/01707

(22) International Filing Date: 23 December 1980 (23.12.80)

(31) Priority Application Number: 107,531

(32) Priority Date: 27 December 1979 (27.12.79)

(33) Priority Country: US

(71) Applicant; and
(72) Inventor: PARKER, Lawrence, J. [US/US]; Route 1, Box 229 A A, Converse, TX 78104 (US)

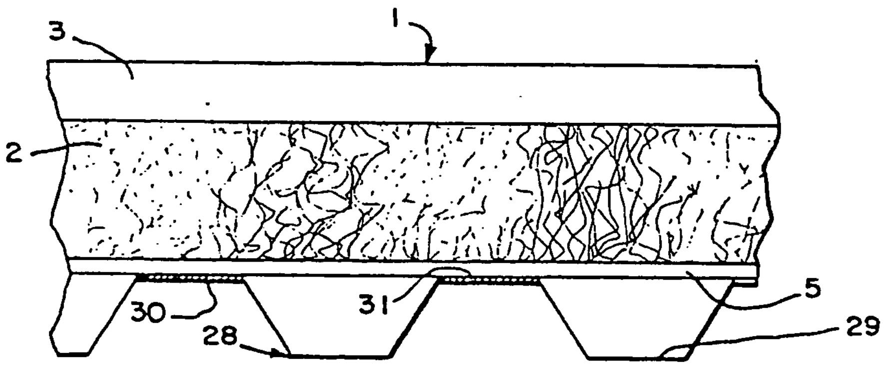
(74) Agents: STAPLER, Alfred et al.; Weiser, Stapler & Spivak, Suite 1510, Two Penn Center Plaza, Philadelphia, PA 19102 (US).

(81) Designated States: AT, DE, FR (European patent), GB, JP.

Published

With international search report
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments

(54) Title: COMPOSITE POLYISOCYANURATE FOAM BOARD



(57) Abstract

A composite roof insulation board (1) produced by applying, between two facing sheets (5), a polyisocyanurate foam layer (2) to a layer of perlite insulation board (3), and introducing the combination between two substantially immovable barriers which restrict expansion of the foam layer, thus forming a composite insulating board having excellent heat resistive and heat insulation characteristics, and which is dimensionally stable. The so produced composite insulation board (1) is then applied to a steel deck roof structure (28) to be insulated, with the perlite layer (3) facing upwardly and the foam layer (2) facing downwardly. The resulting insulated roof structure is capable of meeting the specifications required to be classified as a Class 1 (Factory Mutual classification) roof structure.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BR	Brazil
CF	Central African Republic
CG	Congo
CH	Switzerland
CM	Cameroon
DE	Germany, Federal Republic of
DK	Denmark
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
HU	Hungary
JP	Japan
KP	Democratic People's Republic of Korea
LI	Liechtenstein
LU	Luxembourg
MC	Monaco
MG	Madagascar
MW	Malawi
NL	Netherlands
NO	Norway
RO	Romania
SE	Sweden
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
US	United States of America

COMPOSITE POLYISOCYANURATE FOAM BOARD

BACKROUND OF THE INVENTION

This application is a continuation-in-part of my previous patent application Serial No. 941,057, filed September 11, 1978.

This invention resides in a dramatic improvement in the art of steel deck roof insulation.

Steel deck roofing is a type of construction widely used in modern buildings, particularly large, industrial buildings. Such roofing comprises generally a plurality of longitudinally extending steel beams or cross members, over which are positioned generally planar steel panels, which panels are usually corrugated in order to afford increased strength to the resulting construction.

Normally, steel deck roofing constructed in this manner cannot be left exposed to the elements. This is because the steel which comprises the roof structure affords essentially no insulation from heat and cold. The insulating capability of such a roof, or "R" value, is rated at zero. Accordingly, the interior of a structure provided with such a roof will exhibit widely varying temperatures, requiring constant heating or cooling of that structure to maintain a selected temperature. Maintaining a selected temperature within such a structure often becomes unacceptably costly.

Therefore, it is common practice to cover the exposed steel deck with a thermal insulation layer. This insulation is preferably provided in the form of a plurality of flat, rigid boards, laid side by side on top of the corrugated steel panels.

The upper surface of these insulating boards are then typically covered with a waterproof surface, in order to seal the boards and the steel deck roof from moisture. This generally takes the form of one or more overlapping layers of paper, preferably a felt paper, which are sealed to the steel deck panels and to each other by one or more layers of asphalt.

Thus the roof consists of three distinct elements; the steel deck roof itself, the insulation board above it, and finally the waterproof surface covering the insulation board. Such roofing structures have exhibited adequate thermal insulation and water sealing in operation. However, such roofing structures do not exhibit sufficient heat resisting qualities to pass the standard flame spread tests necessary to allow such products to be used in the construction of steel deck roofing, such as Underwriters' Laboratories construction Class 1 and 2, or Factory Mutual Class 1 construction.

Although improved insulation boards, primarily formed of urethane, have been developed which have improved flame spread characteristics, such boards have proved to be relatively expensive to construct, and still not entirely satisfactory in operation.

In an effort to overcome this problem, workers skilled in the art have looked for alternatives. In U.S. Patent No. 3,510,391 there is shown a composite roof insulation board construction which combines a urethane foam layer with a layer of perlite. A composite insulation board results, possessing the improved flame spread characterisitics of perlite, and the insulating characteristices of urethane.

In accordance with techinques used by those skilled in the art to which this invention pertains, insulation board produced in this manner is then customarily applied to the roof of a structure to be insulated with the perlite layer facing downwardly, separating the urethane foam layer from the interior of the structure. The waterproof covering is then applied to the insulation board construction to seal the materials and thereby complete the roof structure.

Although composite insulation board applied to a structure in this manner serves to provide adequate flame spread characteristics to permit it to pass the above mentioned testing procedures, while maintaining adequate insulting

characteristics, several disadvantages are exhibited by such construction.

These disadvantages stem from the properites of the urethane foam layer of the composite board. Workers of ordinary skill in the art have long known that urethane will not adequately resist the heat of a fire, but rather will break down under such conditions. As a result, insulation board constructed of such material will warp or otherwise deform unacceptably in the event that excess heat, e.g. during a fire, is present. This buckling can eventually lead to the creation of openings in the surface of the insulation board and eventually to the asphalt coating, itself, which coating is coventionally placed over the installed foam board. Not only does this occurrence unaceptably deteriorate the condition of the roof, but it also allows asphalt, which has been liquified by the excess heat, to drip through the roof surface, to the interior of the structure, further complicating matters due to the flammability of the hot asphalt.

For this reason, composite insulation board is customarily applied to a roof with the urethane layer facing upwardly; the perlite layer being positioned between the foam layer and the interior of the structure to reduce heat transfer.

Since the composite insulation board is installed on the roof with the urethane facing upwardly, the facing sheet which is customarily placed over the exposed urethane surface will also be facing upwardly, thereby being exposed to the exterior. This creates additional problems.

For example, in actually installing such roofing boards, it has been found that a marked tendency exists for bubbles or blisters to occur in the facing sheet, beneath the asphalt coating layer, both during and after application of the asphalt to composite roof insulation board materials of the prior art.

Workers is the art have believed that this bubbling effect was due to the production of certain gases during the

reaction of the constituents used to produce the foam, which gases are trapped and later released as the hot asphalt is applied to the insulation board during installation. This bubbling and blistering often increased, as the roof was exposed to the sun over a period of months, often to up to 12 inches or more, due in theory to the escape of additional gases from the foam layer. This bubbling or blistering often proceeded to a point at which the facing sheet began to tear or crack, permitting leakage through to the interior of the structure. Efforts to reduce this effect have not been successful.

Consequently, there is presented a real and presently unsatisfied need to develop a composite foam board which is heat resistive, heat insulative, and which is able to remain uniform and dimensionally stable in a wide variety of applications and environments. In view of the importance of the need to develop energy conserving construction materials which are also able to meet established safety standards, there is an immediate need for such a composite foam board.

SUMMARY OF THE INVENTION

This invention relates to the production of a polymeric insulation board capable of use in conjunction with steel deck roof construction, and in particular to an improved composite roof insulation board having both increased insulating and dimensional characterisitcs, as well as excellent flame spread qualities, and a method for installing such composite insulation boards on the roof of the structure.

It is an object of the present invention to provide a composite roof insulation board of improved construction.

It is another object to provide a composite roof insulation board which is heat resistive, heat insulative and dimensionally stable.

It is another object to provide a composite roof insulation board which will satisfy the testing procedures necessary to permit its use in conjunction with steel deck roof construction.

It is another object to provide a composite roof insulation board having a foam layer and a perlite layer, and which need not be applied to structure with the perlite layer facing downwardly, as were composite roof insulation boards of the prior art.

It is another object to provide a composite roof insulation board which is well suited to receiving a coating of hot ashpalt thereon.

It is another object to provide a composite roof insulation board which is not susceptible to blistering or bubbling upon application to that insulation board of a coating of hot asphalt, or upon exposure of the surface to the sun.

It is another object to provide a roof structure, insulated with a compostie roof insulation material which is heat insulative, heat resistive, dimensionally stable, and which is applied to the roof with its foam layer facing downwardly, and its heat resistive, perlite layer facing upwardly.

It is another object to provide a method for applying, with its heat resistive, perlite layer facing upwardly, a composite roof insulation board to a structure, which insulation board exhibits sufficient heat resistance, heat insulation, and dimensional stability to pass the testing necessary to enable the use of such materials for steel deck roof construction.

It is another object to provide a composite roof insulation board which is easily manufactured, and inexpensive in cost.

In my prior patent application Serial No. 941,057, filed September 11, 1978, there is disclosed an improved polyisocyanurate foam laminate and a process for its

manufacture. The polyisocyanurate foam is produced by admixing two components: one containing a polyisocyanate, a surfactant and a blowing agent; the other containing a polyol component and an isocyanate trimerization catalyst component. Additional detail in this regard may be had by reference to my application Serial No. 941,057, filed September 11, 1978, which is incorporated herein by reference.

The so produced polyisocyanurate foam is then introduced between two flexible sheet substrates (or facing sheets), which materials are then passed between two substantially immovable barriers which restrict the expansion of the laminate caused by foaming of the reaction mixture.

In a preferred embodiment, a fiber mat, generally formed of fiber glass, is first disrupted and caused to expand, whereupon it is positioned between the two flexible sheet substrates. The polyisocyanurate foam reactants are then introduced between the two flexible sheet substrates to form the foam board.

Laminated foam boards produced in this manner exhibit excellent flame spread and dimensional characteristics, and are well suited for use as insulation in steel deck roof construction.

In accordance with my present invention, a layer of perlite insulation material (which is generally shaped to form a board) is positioned between one of the flexible sheet substrates, preferably the substrate which is placed at the bottom of the laminate during its manufacture, and the polyisocyanurate foam layer. This seemingly simple application of new technology to known insulation board forming techniques has surprisingly resulted in a composite roof insulation board which satisfies the many needs long sought by the art to which this invention pertains, which were previously set forth, and which could not be met by the insulation board materials of the prior art.

Unlike urethane, I have found that polyisocyanurate foam boards are not as sensitive to heat. Consequently, polyisocyanurate foam boards do not deteriorate as readily as do urethane boards. In fact, composite polyisocyanurate boards have been constructed which alone are sufficiently heat resistive to pass the necessary testing to allow such materials to be used in conjunction with steel roof construction.

Combining perlite insulation board with such a polyisocyanurate foam layer provides extraordinary flexiblility in the application of the resulting composite roof insulation board to a structure. Contrary to the recognized practices presently used in installing composite insulation boards of the prior art, it has suprisingly been found that it is no longer necessary to install my composite insulation board on the steel deck roof with the perlite layer facing downwardly, as workers skilled in the art has always believed necessary. Rather, the perlite layer may face upwardly on the steel deck roof. Since the polyisocyanurate foam is heat resistive, the application of heat to such a roof will not cause the excessive deterioration and eventual cracking or tearing which would have occurred to composite insulation boards of the prior art had they been installed upside down. A perlite layer placed over the polyisocyanurate foam structure will no longer separate at its butting surfaces, as would have occurred if urethane foams had been used in this manner. The potential for liquified asphalt to drip through to the building interior is also prevented.

This provides significant advantages over the composite roof insulation boards of the prior art, as well as to the roof structures produced using such boards.

Of particular interest is my determination that perlite is a surface well suited to accepting a coating of asphalt to be applied to the roof construction. In addition to the ready acceptance of a coating of asphalt, it has been found that the problems of blistering and bubbling which commonly occurred in conjunction with the use of insulation boards of

the prior art unexpectedly vanish when the composite insulation boards of the present invention are used.

Although not wishing to be bound by the following explanation, it is believed that the bubbles and blisters exhibited by prior art composite boards were not only attributable to gases trapped in the foam layer, as had previously been believed, but rather were also the result of moisture absorbed by the foam layer, and by the facing sheet placed over the foam layer, during the manufacture, shipping and installation of such materials. It is believed that this moisture evaporated when hot asphalt was applied to the composite board structure, causing the moisture to sizzle and evaporate, eventually creating the unwanted bubbles or blisters. Exposure to the sun's heat presented additional heat, and therefore additional complicatons. When the composite insulation board of the present invention is used, the layer of perlite, and not the foam layer with its facing sheet, face upwardly. The problem of blistering vanishes since the hot asphalt, and the sun's heat, are applied to the perlite layer, and not to the foam layer and facing sheet, as in installations of the prior art. There is no longer any opportunity for the openings to develop which commonly occurred in conjunction with prior art laminated insulation boards. An improved weather seal is thus obtained.

Since, unlike prior art composite insulation board structures, the facing sheet of the composite board of the present invention now is applied to the roof facing downwardly, a wider variety of facing materials can be used. In addition to providing an opportunity for cost reduction, the use of hazardous or environmentally questionable materials, such as asbestos, is no longer necessary.

It has been found that the polyisocyanurate foam layer and the perlite layer are well suited for adherence to each other, making the production of composite boards comprising such materials uncomplicated and straightforward. In fact, it

has been found that combining a layer of perlite with a polyisocyanurate foam layer permits the production of a composite board structure having a thinner foam layer, since less polyisocyanurate foam is required to provide the heat resistive values necessary to enable such materials to be used in many appplications.

The foregoing thus provides a composite roof insulation board which is heat resistive, heat insulating, dimensionally stable, and consequently, well suited for use in a wide variety of construction applications, including steel deck roof construction.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross sectional view of the composite roof insulation board of the present invention.

Figure 2 is a schematic view of an apparatus for producing the composite roof insulation board of the present invention.

Figure 3 is a cross sectional view of the composite roof insulation board applied to the roof of a structure.

Throughout the drawings, like reference numerals are used to denote similar structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

There is shown in Figure 1 a preferred emobodiment of the composite foam insulation board 1 of the present invention. Foam board 1 generally comprises a polyisocyanurate foam layer 2, a perlite insulation layer 3 attached to a first side 4 of foam layer 2, and facing sheet 5 attached to the second side 6 of foam layer 2.

Polyisocyanurate foam layer 2 is formed by admixing two components; one component including a polyisocyanate surfactant and a blowing agent; and the other component including a polyol component and an isocyanate trimerization catalyst component. A brief summary of these components follows. Additional details relating to the constituents of the polyisocyanurate foam layer 2 may be ascertained by reference to previous patent application Serial No. 941,057, filed September 11, 1978. (Now Patent No. 4204019)

The first group of constituents, the a)components, are preferably admixed in a closed vessel. The order in which they are added is not particularly critical. This mixing may be done at room temperature.

The second group of constituents, the b) components, actually preferably include a group of six constituents, which are admixed with gentle agitation avoiding the occurrence of turbidity which may be a sign of high acidity. This turbidity has been found to be avoidable if the six constituents, including a diol with a molecular weight less than about 150, a polyol with at least three hydroxyls, polyethylene glycol, an amine salt, a metal carboxylate, and a dimethylaminomethyl-substituted phenol, are gradually added in that order, respectively, either in an open or closed vessel, at room temperature.

These components are admixed in a manner to be more fully described below.

In addition to the nine preferred materials listed above, fillers or other additives may be used to convey characteristics to the foam board, such as increased dimensional stability, density or flame spread qualities. Specific examples include inorganic materials such as magnesium silicate, steel powder, aluminum silicate,. borates, zinc oxide, aluminum powder or flakes or glass particles or fibers. These types of additives may be added to the a) or b) component or may be sprayed or deposited onto the reaction mixture before foaming takes place.

Foam layer 2 also preferably includes a mat 7 formed of an inorganic material, preferably a fibergalss mat, e.g. 10 to 50 mils in thickness. Mat 7 is positioned so that the polyisocyanurate foam is caused to foam on either side of and within the mat 7. This provides added strength and flame spread characteristics to the foam layer 2. Details of the preparation and utilization of such a mat 7, may be found in my prior patent applications Serial No. 941,057 filed September 11, 1978 and Serial No. 965,420 filed December 1, 1978. Although foam layer 2 preferably includes such a mat 7, to provide increased strength and flame spread characteristics, it is also possible to produce foam boards 1 without use of such a mat 7 however a decreased strength and flame spread characteristic will be exhibited.

In accordance with generally recognized techniques, a facing sheet 5 is applied to the side 6 of foam layer 2 opposite to the perlite layer 3, providing a protective covering for the foam layer 2. Facing sheet 5 may be any one of a variety of known products. Facing sheet 5 may be inflexible, e.g. drywall, or even another layer of perlite. Facing sheet 5 may also be flexible, e.g. a kraft paper, a polymeric sheet, an asbestos or other inorganic fiber sheet, a polymeric web, a metal foil, a foil-coated, paper a, resin-impregnated and saturated felt sheet, or a non-woven glass mat which is asphalt-coated or saturated. In particular, an

asphalt-saturated organic felt having a weight of about 12 to 15 pounds per 100 square feet may be used.

Although not illustrated, it is also possible to apply a second facing sheet to the exposed, outer face of the perlite layer 3. Use of such a facing sheet is not required, and in view of its cost, is less desirable. If used, the facing sheet may be formed of any of the various materials set forth above, and may be the same as, or different from the material used for the facing sheet 5.

Foam board 1 may be formed by any of a variety of known apparatus. For example, as illustrated in Figure 2, foam board 1 may be formed on a double phase laminator 8 provided with two parallel platen conveyer belts 9, 11 and a mixing head 10 attached to a traverse (not shown) and capable of rapid movement along the width of the apparatus 8.

Each of the platen coveyer belts 9, 11 comprise a series of juxtaposed platens 12, hingedly connected to each other to form a continuous transportation means. Platens 12 may be formed of a variety of materials and may vary in size. For example, steel plates having a width on the order of 12 inches have been found satisfactory. The ends of conveyer belts 9, 11 are positioned about pairs of opposing, transverse rollers 13, which rollers are adapted to receive the platens 12 as they traverse the rollers 13, yet which also assure alignment between adjacent platens 12 during their travel between the respective rollers 13. The driving gears (not shown) which operate rollers 13, and consequently belts 9, 11, are caused to move in opposite circular directions to convey the materials through the laminator. A suitable parallel platen conveyer belt laminator is described in U.S. Patent 4,043,719, although the limiting means to prevent outward escape of foam taught therein is not necessary in the present invention.

The platen conveyor belts 9, 11 illustrated in Figure 2 are preferably positioned so that the lower surface 14 of the

conveyer belt 9, and the upper surface 15 of the conveyor belt 11, are parallel to each other. It will also be noted that conveyer belt 9 is shorter in length than conveyer belt 11. This is preferred, since it is not necessary to position conveyer belt 9 over the composite foam board 1 during the period of time in which the foam layer 2 is forming.

The input to laminating apparatus 8 is provided with a loading conveyer 16 adapted to receive the perlite boards 3, and a "doctor" or metering roller 17 which is adapted to regulate the amounts of the reactants placed between the facing sheet 5 and the perlite board 3, and consequently, the thickness of the subsequently produced composite foam board 1.

Loading conveyer 16 comprises a continuous belt 18, the ends of which are positioned about a pair of opposing, transverse rollers 19. Loading conveyer 16 is then operated in known manner to convey a series of perlite boards 3, placed on belt 18, toward the laminating apparatus 8, to form the lower portion of the composites board 1 during formation. These perlite boards 3 are typically on the order of 3 feet in length and 4 feet in width; however these dimensions may readily be varied according to need and machine specifications.

The perlite boards 3 are then passed between the doctor roller 17 and the base 20 as illustrated. Also passed between these elements are facing sheet 5, and if used, fiber mat 7. In the event an additional facing sheet is applied to the exposed side 6 of the perlite board 3, such a facing sheet would also be suitably applied at this time. During this procedure, the fiber mat 7, which has generally been expanded previously by fiber disruption, will be compressed, however, it will later recover and again expand as the polyisocyanurate begins to foam.

As the perlite layer 3 and mat 7 are fed into the laminating apparatus 8 there is deposited thereon a mixture of the a) and b) components previously described. The reaction mixture begins to form the foam, later being restricted in its

rise by the top and bottom platen conveyor belts 9, 11, which are set at the desired board thickness. Preferably, there is provided on one or both of the belts 9, 11, a pressure sensing device (not shown) which furnishes an indication when a predetermined pressure is reached. Thus, if the expansion of the reaction mixture is too great, a sensing device or devices may trigger a light whereupon the operator would decrease the amount of reaction mixture deposited per unit area. This may also be done automatically.

Mixing and deposition of the reaction mixture of components a) and b) may be made by mixing head 10 attached to a traverse located in front of the doctor roller 17 and caused to move across and above the perlite boards 3 and mat 7. Preferably, the mixing head 10 moves from one side to another, depositing the reaction mixture on the top of the perlite boards 3 as they move into the laminating apparatus 8. The traverse may be one such as a Leon traverse and the mixing head may be a model such as a Martin Sweets Model No. 4 sold by Martin Sweets Co. of Louisville, Kentucky, or a mixing head sold by the Admiral Machinery Co. division of Upjohn, Houston, Texas, or Henecke Machinery division of Mobay Chemicals. Air may be supplied to the mixing head 10 to deposit a homogenous and consistent reaction mixture and to act as nucleating agent. Further, the mixing head may be provided with an automatic solvent flushing feature whereby the operation can be shut down without clogging the apparatus. The constituents of the foam are preferably supplied to the mixing head 10 from separate lines 21. Components a) and b) can therefore advantageously be prepared and stored for extended periods beforehand.

In order to assist the foam layer 2 in curing, apparatus 8 may optionally be provided with a dryer 22, adapted to direct heated air onto the surface of the foam layer 2 and facing sheet 5, through a series of outlet ducts 23 for example.

A finished, cured laminated foam board 1 will then exit from between the platen conveyer belts 9, 11 at 24 having a perlite layer 3 and facing sheet 5 bonded to a foam layer 2, including a mat 7. Since the perlite 3, and the facing sheet 5, adhere perfectly to the foam layer 2, a strong laminated product results.

It is then possible if desired, to trim the edges of the resulting composite board by edge trimming apparatus 25, forming a regularly shaped product, which may then be cut to any length desired. This cutting operation may be performed, for example, using a cross-cut saw 26, positioned as shown, adapted to move transversely to the board whenever a cutting operation is to be performed. In order to assure that the sections of laminated foam board so produced have regular, perpendicular ends, saw 26 is caused to move in the direction of travel of the laminated foam board 1 during the cutting operation. The finished foam board sections may then be stacked at 27 for packaging and shipment.

Figure 3 illustrates the manner in which composite foam board sections 1 of the type previously described may be applied to the roof 28 of a structure. As previously described, steel sheet sections 29, preferably corrugated for increased strength, are positioned between adjacent steel beams in known manner. To the peaks 30 of the corrugated sections 29, there is applied a coating of asphalt 31, which serves as an adhesive to fixedly connect the composite foam board sections 1 in place.

Due to the unexpected properties exhibited by composite foam board sections formed in accordance with the present invention, the board sections are capable of application to the corrugated sections 29 with the foam layer 2 facing downwardly, and the perlite layer 3 facing upwardly, the facing sheet 5 adhering to the corrugated sections 29 by operation of the ashpalt coating 31.

The resulting structure may then be coated with asphalt and/or felt paper as desired, in order to provide a waterproof seal capable of being exposed to the weather elements.

Unlike previously known insulated roof constructions, the structure above described, in the orientation specified, is sufficiently heat insulative, heat resistive, and dimensionally stable to pass the testing required to qualify as Class 1 (Factory Mutual testing procedure) roof, thus serving to satisfy the various objects previously set forth.

Variations of the foregoing are clearly possible.

Facing sheet 5 may be any one of many known materials. As previously mentioned, the use of asbestos is not required, and consequently, less expensive and less environmentally questionable substances may be used. It is even possible, although less desirable to omit facing sheet 5. Mat 7 may also be formed of any of a variety of materials, although fiberglass is preferred.

Although the foregoing composite foam board has been described to include a layer of perlite as the heat resistive layer, the foregoing description may also apply to other heat resistive materials which are suitably used conjunction with a polyisocyanurate foam.

The above described composite board may be formed in a variey of sizes, including a wide variety of thicknesses, lengths and widths. Board width is determined primarily by the width of the board forming apparatus 8, as well as the width of the raw materials fed into that apparatus. Board length is easily varied by the frequency of the movement of cross-cut saw 26. Board thickness may be varied in several ways. Its overall thickness may be varied by altering the spacing between the doctor roller 17 and the base 20, thereby limiting the amounts of reactants passed there between. The thickness of the perlite layer 3 may be varied by varying the thickness of the perlite insulation board introduced into the appparatus 8.

The thickness of the foam layer may also be varied by modifying the relative proportions of a) components to b) components combined at the mixing head 10. In this manner, a wide variety of foam boards 1 may be forming, having R (Resistance) values ranging between 5.65 and 20.0 and C (Conduction) values of 0.17 - 0.05.

Although the laminating apparatus illustrated in Figure 2 is a restricted-rise type of apparatus, composite boards 1 of the type described in the present application may also be formed on free-rise types of machinery. A variety of board forming devices other than that illustrated in Figure 2 may alternatively be used.

In Figure 2, the perlite layer 3 is illustrated as being placed at the bottom of the composite board during its formation. It is also possible to position to perlite layer 3 along the top of the composite board during its formation, the other elements comprising that board being suitably rearranged to accommodate this.

It may therefore be seen that the above disclosed invention serves well to accomplish the object previously stated. It may also be seen that the above described invention may be embodied in other specific forms in addition to those above disclosed and therefore the disclosure made should be interpreted in an illustrative and not a limiting sense.

WHAT IS CLAIMED IS:

1. A composite foam board comprising

a polyisocyanurate foam layer produced by mixing and reacting components a) and b) wherein

a) comprises a polyisocyanate, a surfactant and a blowing agent, and

b) comprises a polyol component and an isocyanate trimerization catalyst component; and

a layer comprising a board formed of a heat resistive material, on which is deposited the polyisocyanurate foam layer;

whereby the reacting components form a foam, to form the composite foam board.

2. The foam board of claim 1 wherein the heat resistive material is perlite.

3. The foam board of claim 1 wherein the polyisocyanurate foam layer includes a filler selected from the group consisting of inorganic materials, magnesium silicate, steel powder, aluminum silicate, a borate, zinc oxide, aluminum powder, glass particles or flakes, and glass fibers.

4. The foam board of claim 1 wherein the polyisocyanurate foam layer includes a fibrous mat.

5. The foam board of claim 4 wherein the mat is formed of fiberglass.

6. The foam board of claim 1 further comprising a facing sheet applied to the polyisocyanurate layer along the face opposite to which the board layer is applied.

7. The foam board of claim 6 wherein the facing sheet is selected from the group consisting of a kraft paper, a polymeric sheet, an asbestos sheet, a polymeric web and an asphalt-saturated felt sheet.

8. The foam board of claim 1, wherein component a) comprises

i) a polymethylene polyphenylisocyanate;
ii) a silicon-containing polymeric surfactant free of hydroxyl groups; and
iii) a liquid blowing agent having a boiling point less than about 140°F,
and component b) comprises
iv) a diol having a molecular weight less than about 150;
v) a polyol having at least 3 hydroxyl groups;
vi) a polyethylene glycol having a molecular weight of at least 150;
vii) an amine salt;
viii) a metal carboxylate; and
ix) a dimethyl aminomethyl-substituted phenol.

9. A process for applying the composite foam board of claim 1 to the roof of a structure, which process comprises applying the laminated foam board to the roof with the polyisocyanurate foam layer facing downwardly and with the board layer facing upwardly.

10. The process of claim 9 wherein the board layer is formed of perlite.

11. The process of claim 10 further comprising applying a coating of ashpalt directly to the perlite board layer, thereby forming a weatherproof outer seal.

12. The roof structure produced by the process of claim 9.

13. The roof structure produced by the process of claim 10.

14. The roof structure produced by the process of claim 11.

15. A roof structure which comprises a deck which provides the mechanical support, and

a laminate supported by the deck,

the laminate comprising a polyisocyanurate foam layer and an adjoining layer of perlite board,

the foam layer being positioned facing the deck and the perlite layer being positioned facing away from the deck.

1 / 1

FIG. 1

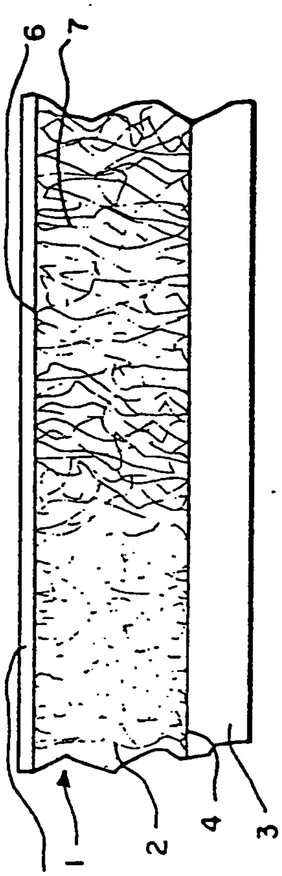


FIG. 2

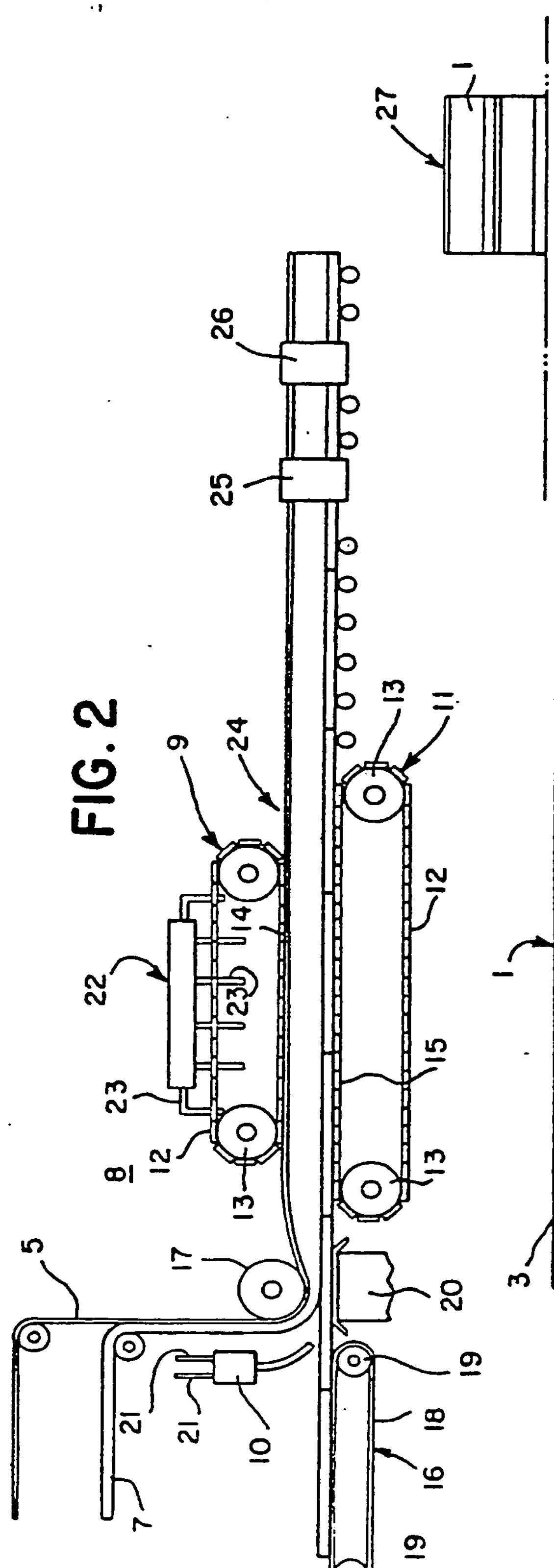
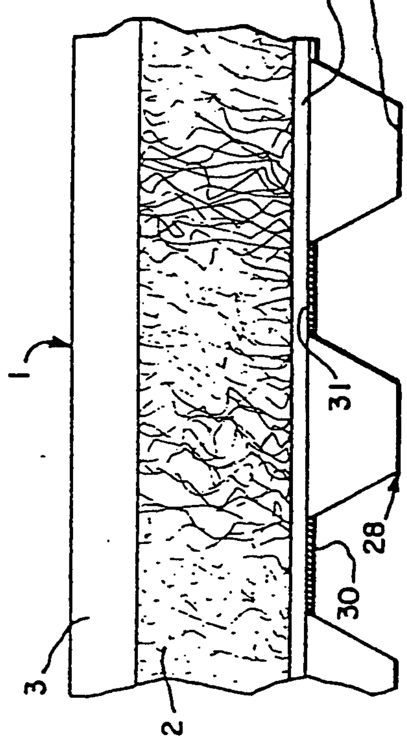


FIG. 3



INTERNATIONAL SEARCH REPORT

International Application No PCT US80/01707

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

INTL. Cl.[3] B32B 3/26, 5/18
U.S. Cl. 428/310

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
U.S.	428/310, 314, 315, 321, 322 156/71, 79

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A 3,978,264, Published 31 August 1976	1-15
A	US, A 3,707,434, Published 26 December 1972	3-5
A	US, A 3,510,391, Published 05 May 1970	6-8
A	US, A 4,118,533, Published 03 October 1978	1-14
A,P	US, A 4,205,136, Published 27 May 1980	1-14
A,P	US, A 4,212,917, Published 15 July 1980	1-14
A	US, A 3,466,222, Published 09 September 1969	9-15
A	US, A 3,492,196, Published 27 January 1970	9-15

* Special categories of cited documents: [15]

"A" document defining the general state of the art

"E" earlier document but published on or after the international filing date

"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
23 APR 1981	08 MAY 1981
International Searching Authority [1]	Signature of Authorized Officer [20]
ISA/US	W. J. Van Bal

Form PCT/ISA/210 (second sheet) (October 1977)